Retrofitting Stormwater Detention Basins

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The major source of pollution in the United States today is nonpoint source pollution. And one of the most significant types of nonpoint source pollution is stormwater runoff from existing developed areas.

Figure 1 - Naturalized Basin for Planned Residential Community

Figure 2 - Constructed Wetland Retrofit at F. X. Browne, Inc. Building

Stormwater runoff from developed areas contains a variety of pollutants including sediments, organic matter, heavy metals, bacteria, and nutrients such as nitrogen and phosphorus. Until recently, the only stormwater control measures used at development sites were conventional detention basins. Conventional detention basins are designed primarily to reduce the peak flow of stormwater runoff. These basins are designed to reduce localized flooding usually by maintaining the peak runoff flow at pre-development conditions. Conventional detention basins do very little to treat the polluted stormwater runoff and improve water quality in the receiving stream. Although they control the peak runoff rate, conventional detention basins do not reduce the volume of stormwater runoff. Large volumes of stormwater runoff enter receiving streams and cause streambank erosion, resulting in increased nonpoint source pollution downstream.

The new Pennsylvania stormwater management manual, presently being completed by DEP, provides criteria for controlling stormwater runoff from new development. These criteria will include peak runoff rate control, runoff volume control, and water quality control. The new Pennsylvania model stormwater management ordinance, being developed concurrently with the stormwater manual, also contains criteria for the control of peak flow rates, runoff volume, and water quality. Presently, the NPDES Part II Permit Application requires a post-construction stormwater management plan that manages the volume and quality of stormwater runoff from new developments. It is clear, therefore, that stormwater from new development will be controlled for peak rates, volume and water quality. The question is, however, how do we provide volume and water quality control for existing developments. One answer is to retrofit existing stormwater detention basins.

There are several ways to retrofit an existing conventional detention basin to provide volume and water quality control. Two of the most common and cost-effective methods are to convert existing detention basins into naturalized basins or constructed wetlands. Although naturalized basins and constructed wetlands can often provide volume reduction and water quality benefits, it is much easier to obtain water quality benefits. In order to achieve volume reduction benefits, the underlying soils in the existing detention basin must have a good infiltration rate and must not be compacted.

A naturalized basin is an attractively landscaped basin containing a variety of native plants including trees, shrubs, and wildflowers. It usually contains a forebay to settle out particulate matter and debris. As shown in Figure 1, a naturalized basin consists of one or more meandering paths to slowly move the water through the basin. These meandering paths have several functions. They reduce the velocity of the water, allowing more contact with the native vegetation. The plants and the epiphytic algae attached to the plants remove pollutants from the stormwater. Another benefit of the meandering paths is the elimination of short-circuiting, a common problem in conventional detention basins. A third benefit of the meandering paths is that the paths in unison with the natural vegetation encourages water infiltration, resulting in groundwater recharge, reduced surface water discharge, and increased stream base flow.

Unlike conventional basins which require frequent mowing, naturalized basins require little maintenance. The most significant maintenance of naturalized basins often occurs after the first growing season. At this time weeding of non-native plants is often needed. Once the native plants grow and dominate the naturalized basins, annual weeding can be significantly reduced or even eliminated. The trees, shrubs, and wildflowers in the naturalized basins also create an aesthetically pleasing environment. In addition to all these human-related benefits, naturalized basins provide wildlife habitat for birds, frogs, turtles, and other wildlife.

Converting a conventional detention basin into a naturalized basin is easy and economical. Listed below are steps needed to convert a conventional basin into a naturalized basin:

- Remove the impervious low flow channel.
- Modify the outlet structure so that smaller storms are held in the basin longer.
- Design and install a forebay to collect particulate matter and debris.
- Design and install one or more meandering paths (depending on the number of inlets to the basin) to slow the water and maximize contact with the native vegetation.
- Ensure that the retrofitted basin has the volume and hydraulic capacity of the conventional detention basin.

Constructed wetlands have all the features and benefits of naturalized basins. The main difference is that constructed wetlands are designed to maintain wetter conditions than naturalized basins. Because of these wetter conditions, the native plants must be more hydrophilic than those in naturalized basins. One problem with small constructed wetlands is maintaining the wet hydrological conditions required. In order to maintain these conditions, it is often required that the underlying soils have a low infiltration rate or even a zero infiltration rate. Because of this, constructed wetland retrofits usually only provide water quality benefits. Unlike naturalized basins that often provide volume control via groundwater recharge and evapotranspiration, constructed wetlands only provide volume control by evapotranspiration. Good examples of constructed wetlands retrofits are the F. X. Browne, Inc. retrofit shown in Figure 2 (and on the cover of this publication) and the Villanova University retrofit shown in Figure 3.

In summary, retrofitting of existing conventional detention basins using either naturalized basins or constructed wetlands can significantly improve water quality in receiving streams. Secondary benefits include the creation of an aesthetically pleasing environment and a habitat for wildlife. ■

Figure 3 - Constructed Wetland Retrofit at Villanova University